Spatial-Temporal Clustering of Chicago Homicides

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Abstract

There was significant (P<.01) nonrandom spatial-temporal clustering (on a scale from 0 to 5 km and 0 to 30 days) of those homicide incidents in Chicago, Illinois, (1965-1990) in which men killed unrelated men in the context of gang activities and other social conflicts, but not in robbery-burglary homicide incidents. The GIS spatial point patterning algorithms (Splancs™) scale for the number of incidents that would be expected given the extent of spatial and temporal clustering, considered separately.

Between 1965 and 1990 in the city of Chicago, 19,335 people were homicide victims. There was marked variation in the number of victims from year to year (Block and Christakos, 1995) and from neighborhood to neighborhood (Wilson and Daly, 1997), but was there clustering of homicides in space and time? Asynchronous deterioration or improvement of different neighborhoods would be expected to cause nonrandom spatial-temporal clustering on a relatively long (e.g., annual) time scale, but we were interested in whether there might also be nonrandom spatial-temporal clustering on a scale of days or weeks, and blocks. Our interest derives from the expectation that any such clustering might be a signature of one or more of the following social processes: (1) social contagion, including copy-cat murders, power struggles, revenge, and retaliation; (2) nonrandom distribution in space of temporal changes in factors that elevate the risk of homicide; (3) changes in market dynamics.

How to Measure Clustering in Space and Time?

Peter Diggle and colleagues (Diggle et al., 1995; Gatrell et al., 1996) have devised GIS spatial point patterning algorithms which treat each incident (here a homicide) as a focal point for computing observed and expected numbers of additional incidents within a continuously varying radius (s) and time interval (t), in order to determine the degree of space-time clustering in excess of that which would be expected given the extent of spatial clustering and the extent of temporal clustering, considered separately. The resulting numerical value for each s/t combination is a standardized index denoted as D/SE. If there were no space-time clustering, the surface of the 3-dimensional graph (with axes of s, t, and D/SE) would be relatively flat, even if temporal trends and spatial clustering existed. In order to assess whether the 3-dimensional surface pattern is statistically improbable, Monte Carlo simulations are run utilizing the same degree of spatial clustering and temporal clustering. If the sum of the standardized indexes (sum of all D/SE values) is greater than 99% of the obtained simulation values, then P<.01.

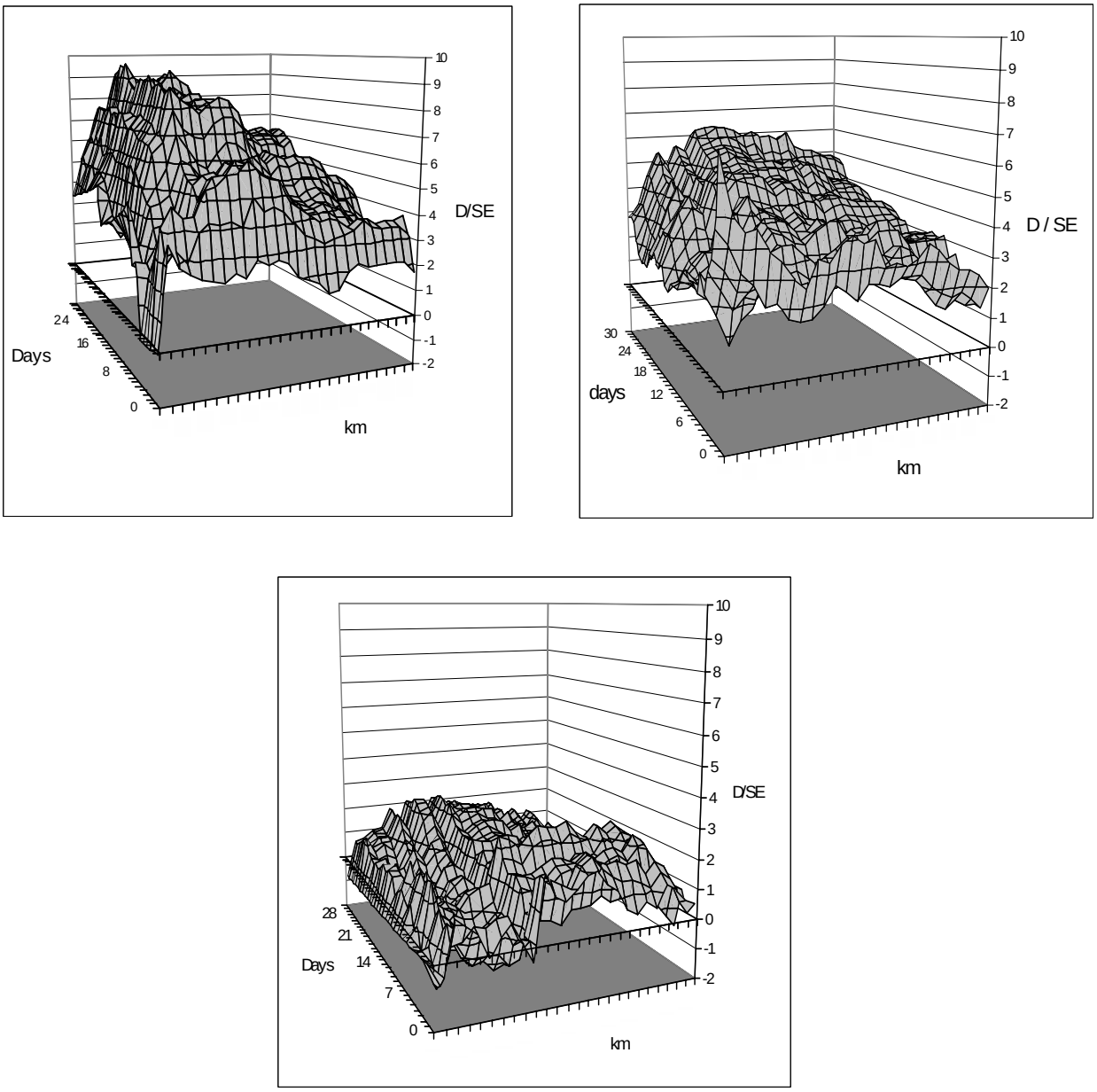
We limited analysis to distances of 0-5 km between any two homicide incidents and intervals of 0-30 days. Incidents are the units of analysis. We asked whether there was nonrandom spatial-temporal clustering of men killing unrelated men in gang-related homicides, other "social conflict" homicides, and robbery-burglary homicides in Chicago over the period 1965-1990.

Results and Discussion

Figure 1 shows the 3-dimensional surface pattern of the standardized index, D/SE, of spatial-temporal clustering. Index values greater than 2.0 are likely to be statistically improbable as assessed with Monte Carlo simulations. The probability of the overall surface pattern was statistically significant ($P<.01$) for gang-related incidents and for other social conflicts, but the pattern for robbery/burglary incidents was not significant ($P=.11$). Note that the surface of the robbery/burglary graph is relatively flat compared with the other two kinds of homicide incidents.

Diggle's method allows one to detect space-time clustering at whatever scale such clustering may actually exist. Interpretation of the observed patterns still requires theory, appropriate control comparisons, and imagination. Interpretation of the three graphs in Figure 1 requires consideration of the social processes and structural forces that underlie the different kinds of homicide incidents.

Figure 1. Space-time clustering index (D/SE) for gang-related incidents (upper; N=1,139), other social conflict incidents (middle; N=7,509), and robbery/burglary incidents (lower; N=1,956) in Chicago 1965-1990. Cases are those in which victim and killer were unrelated males.



Acknowledgments

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Development of an Ultrasonic Method for Restoration of Obliterated Serial Numbers on Firearms

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Introduction

There is a recognized need for a method which will be able to restore an erased serial number on firearms.

One of the instruments that might help to achieve this goal is the acoustic microscope. The basic concept that stands behind this attempt is that the action of pressing the numbers on the surface of the firearm produces a local stress concentration below the numbers. These stresses still exist after the numbers have been erased.

The cause for the stresses comes from the local strains caused by the action of pressing the numbers into the material.

When the ultrasonic parameters are appropriate, then the acoustic microscope is able to see these stresses. Mapping of the stress on the firearm can differentiate between areas with and without stress. As a result of this property, we might get a picture of the erased numbers.

The results of the scanning probably won't give us the image of the full numbers, but further processing of the picture might give us a clue and even more of the original numbers.

Goals

- To find a method in which a firearm's serial number, that has been erased, will be restored.
- To try to define the optimum dimensions and geometry for the letters, which will give us the best capability for restoration of the numbers.
- To look for new methods to mark the serial number that will help the restoration of it later, in the acoustic microscope.

The Acoustic Microscope Scanner

The scanner is based on a computerized ultrasonic system in which a sample is held in a bath of a liquid, usually water, and scanned. As a result, we a re receiving an image of the area, in which each pixel represents the change in amplitude in that place.

The changes in amplitude are usually caused by defects in the sample, changes in the materials due to thermal treatment, changes in geometry, stresses, etc.

Shear and Longitudinal Waves

The waves that penetrate the material split into two modes: one is longitudinal waves, and the second is shear waves. They differ by their polarity. The longitudinal waves vibrate in the direction of the beam, and the shear waves are polarized perpendicular to the direction of the beam.

We are using the shear waves because they are more sensitive to stresses.

Leaky Waves

The leaky waves are waves that we are producing by working at a distance much closer to the material, in that often we are making surface waves that leak through the surface of the material. These waves are sensitive to defects of the surface of the material, including surface roughness and stresses at the surface. As we mentioned before, stresses that were caused by the serial numbers can be detected by the stresses that are left after they have been removed.

Experimental

The experiments have been done on a few metallic samples. We used steel plates that were cut from firearms made by New England Firearms Co. and steel plates that we got from the ATF.

The first plates were machined from their backside and then scanned in the SCM (Scanning Acoustic Microscope), from their back using shear waves. As a result, we got a mirror picture of the numbers.

The first step was to polish the numbers, in controlled steps, and then to scan them again, until we didn’t detect the numbers anymore. In this stage, we measured the maximum depth in which the number can be detected by this method. These experiments were done on both plates.

Results

We have tried to find a method to restore the numbers after they have been erased, but we didn’t succeed. We suspect that the problem lay on the transducers that we have. We suspect that the

field of stresses near and below the numbers is small and for that we need a special transducer, that at this stage we don’t have.

Future Research

Our goals for future research are:

- To find a simple way to restore the serial numbers from a firearm after they have been erased. In this research, we will need to find a good fit between the material in use, the transducer, and the ultrasonic scanner. In the meantime, we are working with the existing equipment.

- To define a standard for the serial number (the size and depth of the letters), that will help us in the future to restore the numbers after they have been erased.

- To define the location for the serial number in a place that will make the restoration of it easy, but still the grinding of it will be difficult.

COHORT SURVIVAL PROJECTIONS OF HOMICIDE RATES: VICTIMIZATION TYPES

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ABSTRACT

Cohort survival projections of homicide victims multiply the projected *number* of people of a given age by the projected victimization *rate* for people that age. Projecting age-specific victimization rates looks complicated, because these rates do not merely rise and then fall, they fall (from infancy to about age 12), rise (from age 12 to about age 25), fall (from age 25 to about age 70) and then rise again. One approach may be to partition homicides into a small number of different types, each of which has a relatively simple relationship to age. This paper describes a set of homicide types that meets this objective.

AGE DISTRIBUTION OF ARREST RATES MUCH SIMPLER THAN VICTIMIZATION RATES

FIGURE 1--RISK OF HOMICIDE ARREST

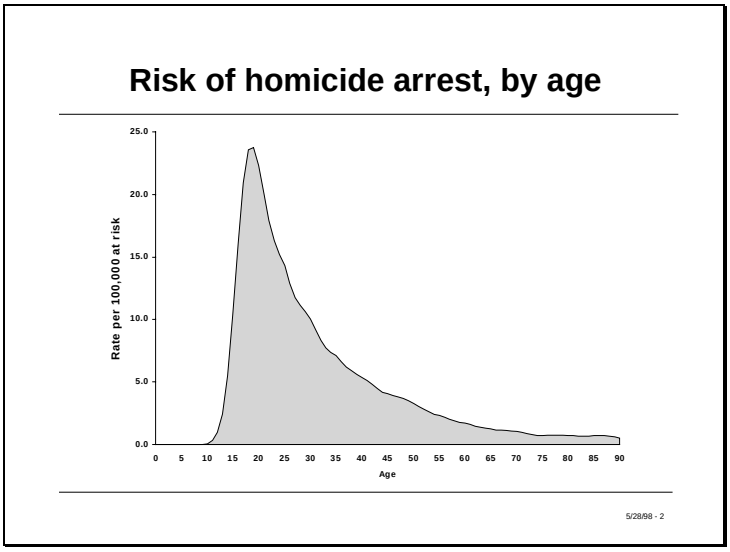
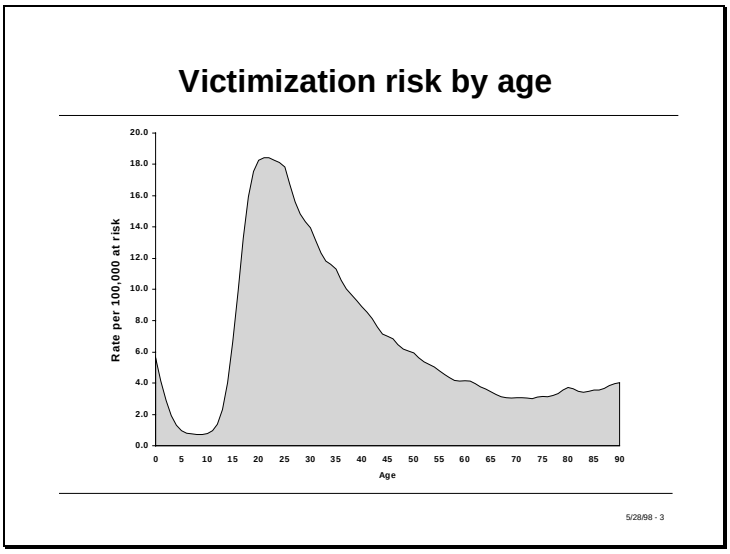


Figure 1 shows the arrest rate for homicide by age[1]. While this figure displays rates for all persons for a particular period of time, it resembles what age specific arrest rates for a birth cohort would look like if we had the data to draw such a curve. Rates rise sharply after about age 10, to a peak at about age 20, and then decay steadily from that age on. It seems to suggest a simple process of initiation and desistance. Because this distribution can be described with just a

[1] All charts in this report were drawn using data describing 100,784 victims of non-justifiable murder and non-negligent manslaughter in the Supplemental Homicide Reports for the five years 1988 through 1992, and estimates of the resident population obtained from the Census Bureau.

few parameters, it is relatively easy to project age specific homicide arrest rates for a birth cohort.

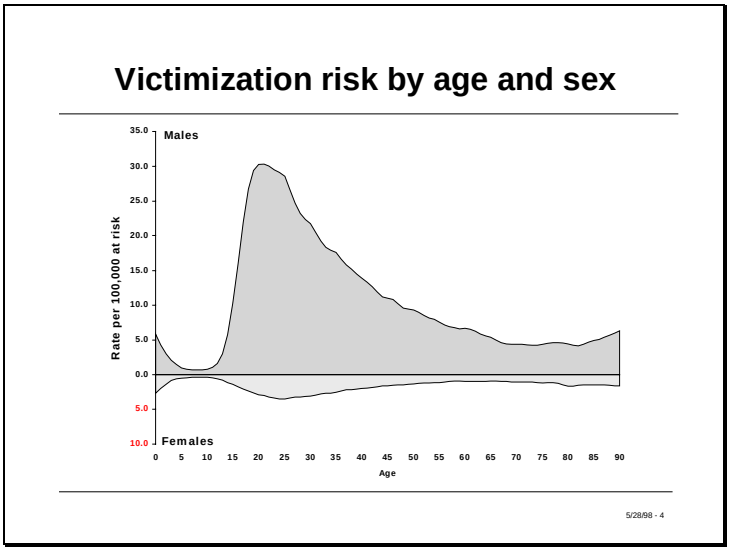
FIGURE 2--VICTIMIZATION RATES



As Figure 2 shows, the corresponding risk of being a homicide victim has a much more complicated shape. It begins in the first year of life at a relative high rate, falls quickly to about age 7 or 8, rises sharply during the teen age years, falls steadily until about age 75, then begins to rise again. It is difficult to view exposure to homicide risk as a simple process of initiation followed by desistance, and we cannot characterize the shape of this curve with just a few parameters.

Figure 3 shows victimization rates by age and sex, with rates for females “pointing down”. The figure is like a population pyramid on its side. Both male and female rates have the same shape: a fall, followed by a rise, followed by a fall, followed by a rise. For most homicide types, rates for males are higher than for females.

FIGURE 3--RISK BY AGE AND SEX



VICTIMIZATION TYPES

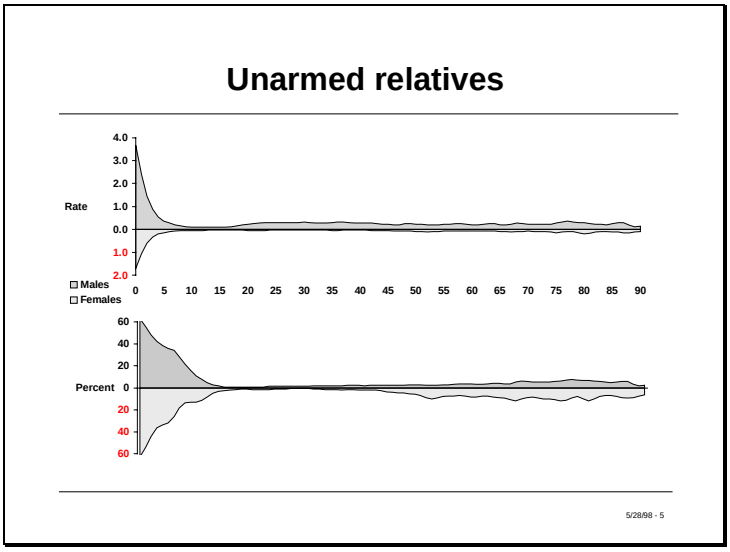
While we can imagine that activities that affect the probability of getting arrested for homicide might follow a simple lifetime trajectory of initiation followed by desistance, we cannot do so for victimization. Instead, perhaps, we can think of the net exposure to victimization as a consequence of exposure to several *different* trajectories, each with its own relatively simple characteristics. Once victimizations are so partitioned, it may be possible to make projections for each type with some simple model, and then combine them.

To explore this idea, I have partitioned homicides into ten mutually exclusive classes. I present, one after the other, roughly in the order in which each class seems to pose the greatest risk, from youngest to oldest. I make no claim for originality; others have discussed much that will appear below[2].

In what follows, I will display the types roughly in the order of the age at which they present the largest risk of victimization. I give each type a rather simple title, but because the types are mutually exclusive, this title does not fully describe the definition of the type. See the appendix for this definition.

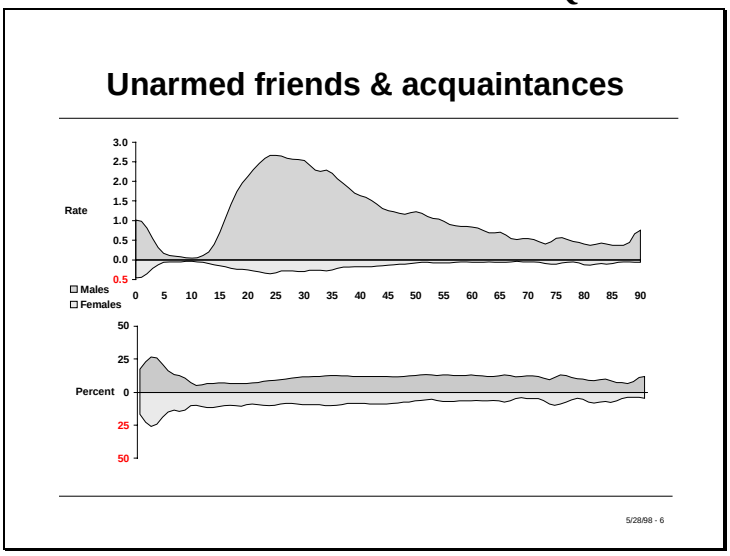
[2] Nelsen, Candice and Lin Huff-Corzine (1998). "Strangers in the Night: An Application of the Lifestyle-Routine Activities Approach to Elderly Homicide Victimization." *Homicide Studies*, 2: 130-159.

FIGURE 4--UNARMED RELATIVES



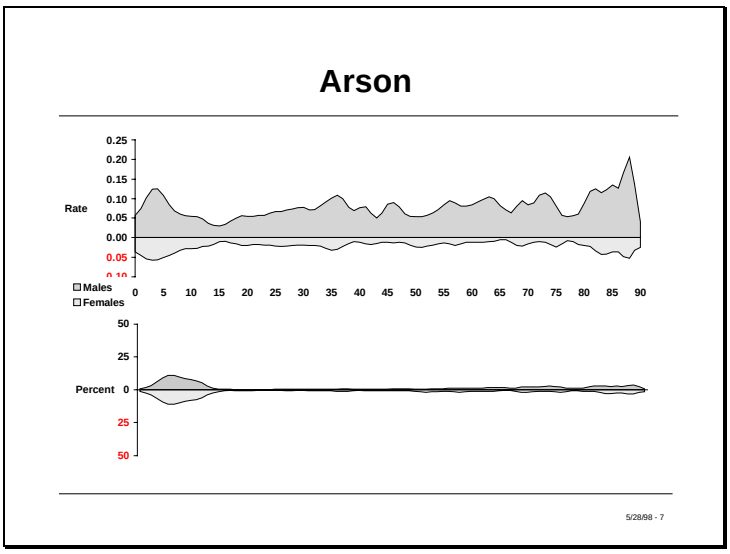
As Figure 4 shows, infant victims are most likely to be killed by unarmed relatives (here and everywhere else in this paper, by "unarmed" I mean "unarmed with a gun"). The top graph shows the victimization rate (victims per 100,000 at risk) by age and sex (males above the horizontal axis, females below it). The lower graph shows the percent of all homicides in which the offender was known to be an unarmed relative, by age and sex (males above the axis, females below). It is hard to understand why the rate for male infants is nearly twice that of female infants.

FIGURE 5--UNARMED FRIENDS AND ACQUAINTANCES



As Figure 5 shows, the other big risk faced by children is homicides by unarmed friends and acquaintances (but not relatives). Homicides of this type account for about a quarter of all children around the age of four.

FIGURE 6--ARSON



In Figure 6 we see that, while an arson homicide is a very rare event, it accounts for a distinct fraction of all homicides victims ages about 5 to 10 years old.

FIGURE 7--ARMED FRIENDS AND ACQUAINTANCES

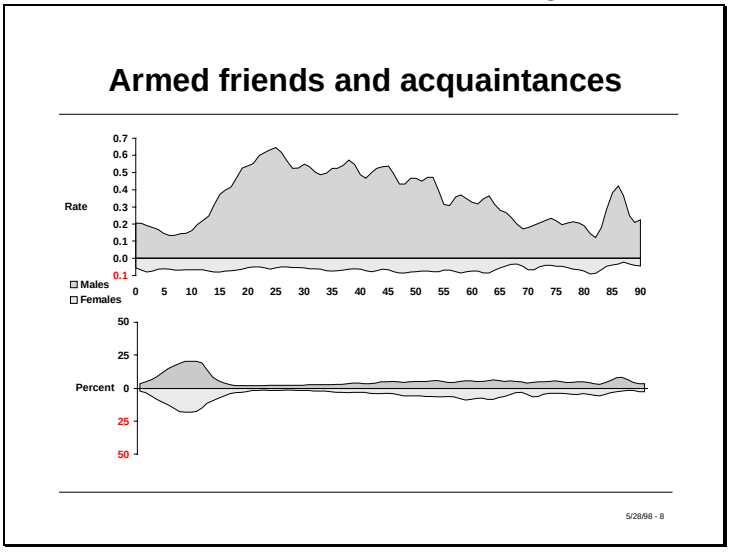
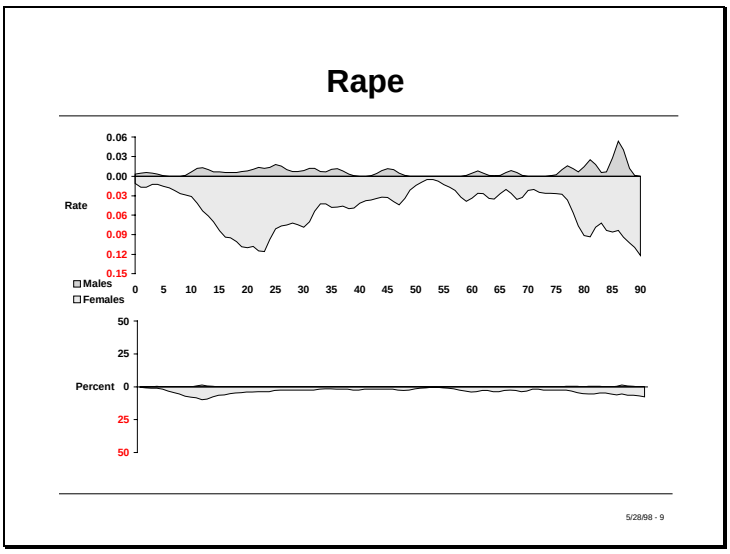


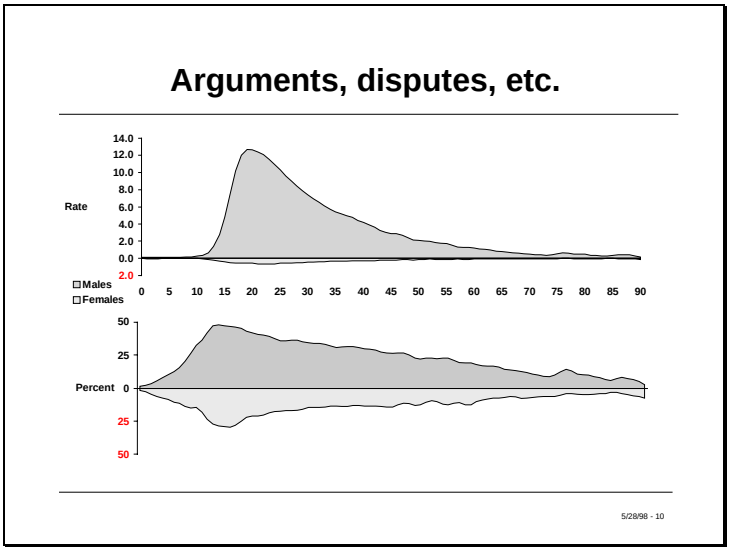
Figure 7 shows that homicides by armed friends and acquaintances accounts for about a quarter of all homicides of children around the age of 10.

FIGURE 8--RAPE



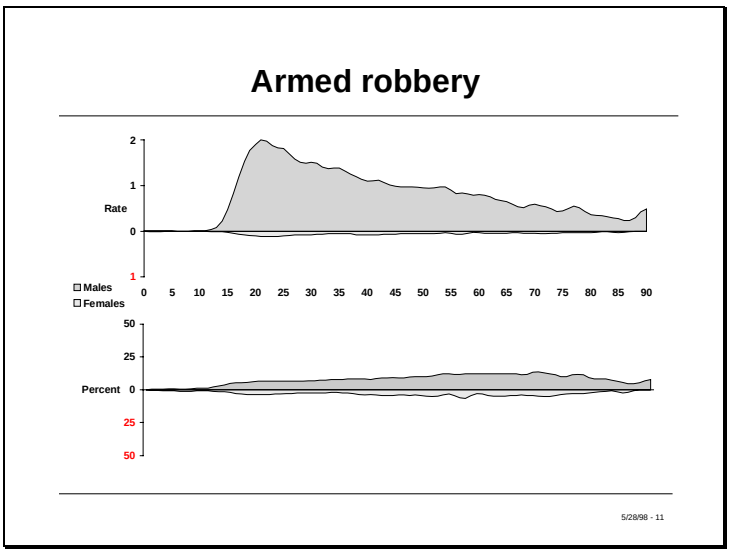
As Figure 8 shows, homicides involving rape are mostly females. The age at which rape accounts for the largest fraction of female homicides is around 12. That there are any rapes for infants, particularly that of males, is probably an artifact of the way homicides are coded. In a multiple victim homicide, some of the coded facts are those that characterize the first victim listed. If a mother is killed in the course of a rape, and her child is also killed, if the mother is the first listed victim the child will be coded has have been killed during a rape, but the child itself may not have been raped.

FIGURE 9--ARGUMENTS, DISPUTES, ETC.



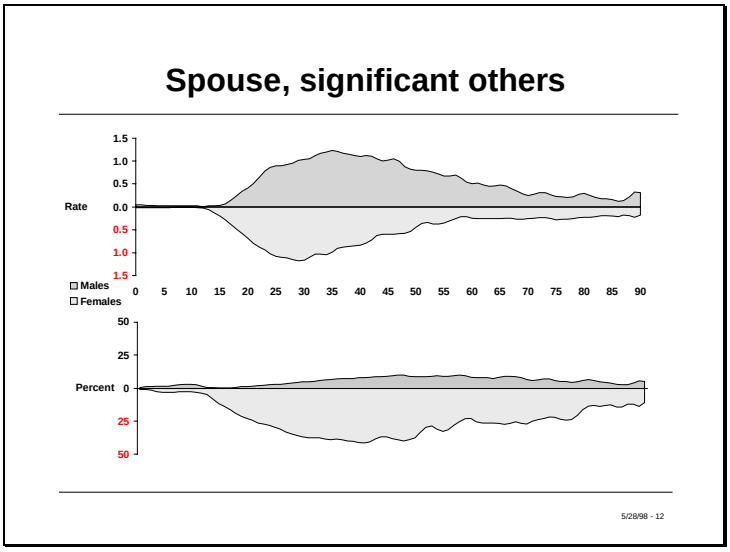
As seen in Figure 9 the class of homicides that I call arguments and disputes accounts for most homicide victims. The rate profile by age looks very similar to the age profile of arrests, and perhaps we have here a broad class of homicides that, like arrests, can be characterized by initiation during the teen-age years followed by a steady desistance for the rest of life.

FIGURE 10--ARMED ROBBERY



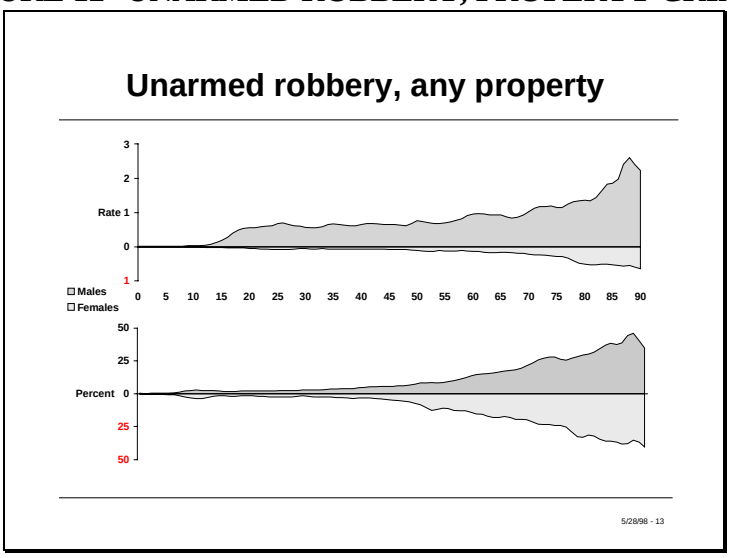
Armed robbery, as shown Figure 10, has a pattern similar to arguments and disputes, but the rate peaks at a slightly later age, and accounts for the largest fraction only in old age.

FIGURE 11--SPOUSES, SIGNIFICANT OTHERS



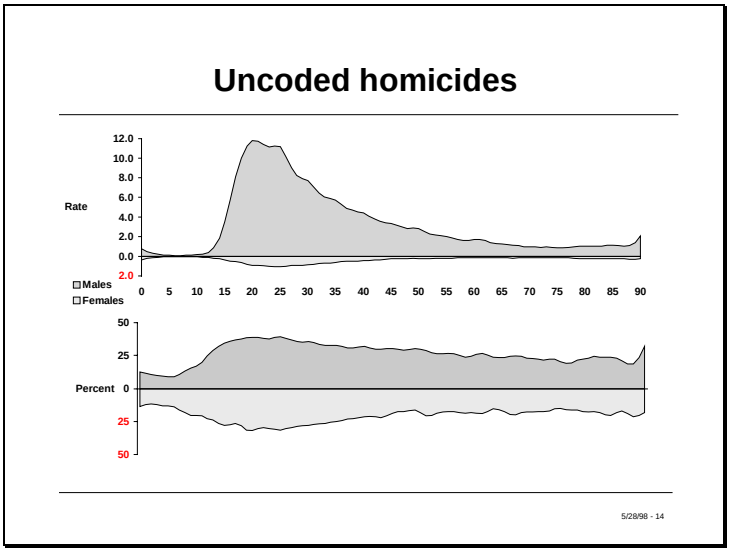
Getting killed by your spouse, ex-spouse, boy/girl friend, etc. is a risk you face relatively late in life, as Figure 11, and later for men then for women. Such homicides account for nearly half of women killed around age 40.

FIGURE 12--UNARMED ROBBERY, PROPERTY CRIMES



As Figure 12 shows, being a victim of a homicide committed during the course of a non-gun robbery, or a burglary or theft, is an increasing risk in the latest years of life. One could hypothesize two different reasons for this phenomenon: (1) older victims are more frail and thus less likely to survive injuries received in the course of an attack, (2) older victims are perceived by predators as being weaker, and thus older folks are more likely to be targets of such attack.

FIGURE 13--UNCODED HOMICIDES



All the homicides whose nature I couldn't figure out I call *uncoded* homicides, instead of using a word like *unknown* which leads to confusion[3]. Figure 13 shows the distribution of uncoded homicides. People who code homicide files seem to know more about homicides of children than

[3] Riedel, Marc (1998). "Counting Stranger Homicides: A Case Study of Statistical Prestidigitation." *Homicide Studies*, 2:206-219.

homicide of older people. However, it may also be the case that when faced with the death of a child, if little can be determined about the circumstances, the death is less likely to be recognized as a homicide.

APPENDIX: DEFINITION OF THE HOMICIDE TYPES

The ten homicide types were defined using the circumstance, relationship and weapon codes in the Supplemental Homicide File. The following table shows how. Counts are taken from the Supplemental Homicide Files for the years 1988 through 1992, and are counts of murder and manslaughter only.

		Unarmed					Armed				
Type	Circumstance	Spouse	Relative	Friend	Stranger	Un-coded	Spouse	Relative	Friend	Stranger	Un-coded
1 Spouse	2 Rape	11					1				
	3 Robbery	22					10				
	5 Burglary	3					9				
	6 Larceny						2				
	7 Auto theft	1									
	9 Arson	27					4				
	17 Other sex offense	11					8				
	18 Narcotics laws	18					14				
	26 Other felony	63					86				
	40 Lovers triangle	122					280				
	41 Killed by babysitter	2									
	42 Brawl under alcohol	111					109				
	43 Brawl under drugs	23					20				
	44 Argument over money	77					94				
	45 Other arguments	2543					3628				
	46 Gangland killing						1				
	47 Youth gang killing						2				
1 Spouse (continued)	48 Institution killing	2									
	60 Other	609					1399				
	70 Suspected felony	8					12				
	99 Unknown	296					510				
2 Rape	2 Rape		19	184	151	238		2	27	29	24
3 Arson	9 Arson		122	210	84	303			6	5	22
4 Armed robbery	3 Robbery							47	1068	2963	2188
5 Unarmed robbery	3 Robbery		101	1028	1061	1065					
or any property	5 Burglary		10	127	191	214		14	127	206	131
	6 Larceny		4	24	13	9		2	22	52	7
	7 Auto theft		4	22	42	19		2	23	100	25
6 Unarmed relative	17 Other sex offense		14								
	18 Narcotics laws		23								
	19 Gambling		1								
	26 Other felony		229								
	40 Lovers triangle		19								
	41 Killed by babysitter		26								
	42 Brawl under alcohol		68								
	43 Brawl under drugs		22								
	44 Argument over money		103								
	45 Other arguments		1072								
	47 Youth gang killing		1								
	60 Other		1795								
	70 Suspected felony		10								
	99 Unknown		321								

Type	Circumstance	Unarmed					Armed				
		Spouse	Relative	Friend	Stranger	Un-coded	Spouse	Relative	Friend	Stranger	Un-coded
7 Unarmed friend	10 Prostitution			21							
	17 Other sex offense			91							
	18 Narcotics laws			495							
	19 Gambling			10							
	26 Other felony			183							
	40 Lovers triangle			303							
	41 Killed by babysitter			118							
	42 Brawl under alcohol			600							
	43 Brawl under drugs			151							
	44 Argument over money			610							
	45 Other arguments			4903							
	46 Gangland killing			40							
	47 Youth gang killing			97							
	48 Institution killing			73							
	49 Sniper attack			1							
	60 Other			1557							
	70 Suspected felony			57							
	99 Unknown			994							
8 Armed friend	17 Other sex offense							4			
	18 Narcotics laws							33			
	19 Gambling							3			
	26 Other felony							61			
	40 Lovers triangle							27			
	41 Killed by babysitter							2			
	42 Brawl under alcohol							80			
	43 Brawl under drugs							11			
	44 Argument over money							144			
	45 Other arguments							1776			
	60 Other							807			
	70 Suspected felony							6			
	99 Unknown							301			
9 Other codes	10 Prostitution				20				15	12	
	17 Other sex offense				25				32	8	
	18 Narcotics laws				124				2285	637	
	19 Gambling				5				75	9	
	26 Other felony				89				280	211	
	40 Lovers triangle				33				846	82	
	42 Brawl under alcohol				149				770	238	
	43 Brawl under drugs				12				572	106	
	44 Argument over money				52				1206	139	
	45 Other arguments				1162				8782	1960	
	46 Gangland killing				21				201	131	
	47 Youth gang killing				60				1072	725	
	48 Institution killing				8				1		
	49 Sniper attack								22	64	
	60 Other				476				2344	1004	
	70 Suspected felony				44				86	59	
	99 Unknown				365				1574	868	

Type	Circumstance	Unarmed					Armed				
		Spouse	Relative	Friend	Stranger	Un-coded	Spouse	Relative	Friend	Stranger	Un-coded
10 Uncoded	10 Prostitution					30					9
	17 Other sex offense					47					9
	18 Narcotics laws					264					2535
	19 Gambling					2					9
	26 Other felony					221					377
	40 Lovers triangle					10					27
	41 Killed by babysitter					2					
	42 Brawl under alcohol					81					107
	43 Brawl under drugs					49					280
	44 Argument over money					30					97
	45 Other arguments					899					2241
	46 Gangland killing					12					135
	47 Youth gang killing					62					1182
	48 Institution killing					15					
	49 Sniper attack										104
	60 Other					698					1052
	70 Suspected felony					323					410
	99 Unknown					7152					13527